WORKING DRAFT
Green and White Sturgeon
Conservation Themes with Stressors, Impact Mechanisms, and Conservation Measure Concepts

Note: Information presented in this draft table is a preliminary work in progress and will continue to be refined based on new information as it is gathered. Citations and other documentation supporting the information will be provided in or appended to the table as more specific information is developed. This table was prepared by the following individuals at BDCP technical working sessions held on April 4, 2007: Diane Windham and Jeff Stuart (NMFS); Scott Cantrell and Tom Schroyer (DFG); Zoltan Matica and Alicia Seesholtz (DWR); Rick Sitts (Metropolitan); Campbell Ingram (TNC); Josh Israel (UC Davis); and Pete Rawlings (SAIC). To prepare the information presented in this table, technical working session participants were requested to identify known and potential stressors without regard to the relative importance of and uncertainties associated with stressor effects and to identify potential conservation measure concepts without regard to their likely effectiveness in addressing stressors or their implementation feasibility. Life stages that could be affected by a stressor are indicated by an "X" in the table and life stages that are not believed to be affected by a stressor are indicated by a "0".

HANDOUT #4
CONSERVATION THEMES AND STRESSORS

Conservation Theme	Stressor	Impact Mechanism	Life Stages				Conservation Measure Concepts
			Egg	Juvenile	Subadult	Adult	
1. Reduce sources of mortality				(<100 cm)	(>100-150 cm)	(>150 cm)	
1-1	SWP entrainment	▪ Entrainment into Clifton Court Forebay (CFF)[1] ▪ Loss through louvers	0	X	X	X[2]	▪ Install fish screens ▪ Improve louvers ▪ Real-time/Seasonal operations ▪ Increase outflow (?)[3] ▪ Relocate intake and improve screening (multiple intakes, new channel) ▪ Prevent entry of fish into CCF ▪ Improve velocity management and louver guidance ▪ Modify radial gate structure/operations ▪ Intertie between SWP and CVP, joint pumping, fill San Luis early to provide flexibility in operations, preferential diversion operations based on fish densities and losses ▪ Increase diversion capacity to improve operational flexibility ▪ Keep screens flush with channel bottom[4] ▪ Decrease exports

[1] Predation losses for sturgeon within CCF are unknown.
[2] Green sturgeon are rare
[3] Pulse flow likely would not work based on timing of downstream sturgeon migration
[4] Probably minimal number/check salvage data (hang in hole at radial gate CCF)

1-1b	CVP entrainment	▪ Loss through louvers	0	X	X	X	▪ Install fish screens ▪ Real-time/seasonal operations ▪ Increase outflow ▪ Relocate intake and improve screening (multiple intakes, new channel) ▪ Rebuild or refurbish existing louver facility ▪ Intertie between SWP and CVP, joint pumping, fill San Luis early to provide flexibility in operations, preferential diversion operations based on fish densities and losses ▪ Reduce exports ▪ Maintance of screens to ensure screens are maintained flush with channel bottom
1-2	SWP/CVP salvage	▪ Collection, Handling, Transportation, Release (CHTR) mortality[5]	0	X	? (need to check salvage data)	0	▪ Install fish screens ▪ Improve louver guidance ▪ Improve CHTR process ▪ Seasonal operations ▪ Relocate intake and improve screening ▪ Multiple release sites ▪ Different techniques for release (e.g., barge vs. truck)
1-3	CCF predation	▪ Predation	0	0	0	0	▪ Predator management/removal ▪ Modify Forebay[6] ▪ Remove Forebay ▪ Install fish screens ▪ Relocate intake
1-4	DWR owned diversions	▪ Loss at unscreened diversions (Twitchell)	0	?[7]	0	0	▪ Install fish screens ▪ Consolidate diversions ▪ Remove diversion ▪ Seasonal operations

[5] Directed primarily at post-release entrainment and predation mortality.

[6] For example, install screen/leaky rock levee so fish pass quickly through narrower channel to salvage facility, increase velocity to reduce residence time, forebay bypass to allow fish to be removed before water enters forebay.

[7] May be susceptible if high flows push small fish downstream

1-4b	DWR Operated Bypasses	▪ Fish stranding[8]	X[9]	X	X	X	▪ Build fish passage ▪ Regrade/engineer to improve drainage (e.g., scour pools) ▪ Recover stranded fish and move past barrier ▪ Remove low flow channel barriers (toe drain) ▪ Improve/add fish ladders/expand fish ladders, passage at Fremont Weir/Lisbon Weir/Tisdale Weir
1-4c	DWR Operated Bypasses	▪ Upstream passage barrier delays migration sufficiently to result in mortality	0	X[10]	0	0	▪ Build fish passage ▪ Recover stranded fish and move past barrier ▪ Screen to prevent fish access[11]
1-5	USBR owned diversion (Rock Slough-CCWD uses)	▪ Loss at unscreened diversion	0	0	0	0	▪ Install fish screens ▪ Consolidate diversions ▪ Remove diversion ▪ Seasonal operations ▪ Encase Rock Slough canal
1-6	Private unscreened diversions (e.g., urban, industrial, agricultural diversions, Glenn-Colusa)	▪ Entrainment loss	X[12]	X	0	0	▪ Install fish screens ▪ Consolidate diversions ▪ Remove diversion ▪ Seasonal operations
1-6b	Mirant Pittsburg and Contra Costa power plants	▪ Entrainment losses[13]	0	X[14]	?	0	▪ Retire/replace power plant units equipped with off-stream cooling ▪ Install improved fish screens ▪ Consolidate diversions ▪ Remove diversion ▪ Seasonal operations ▪ Reduce discharge temperatures ▪ Optimize variable speed circulating water pump drive (VSD) operations

[8] This is also a stressor and impact mechanism for splittail.
[9] May spawn in bypasses under some conditions
[10] Egg to juvenile survival—spawn in bad locations
[11] It may not be feasible to screen bypasses because of bypass width and magnitude of high flows.
[12] South of Hamilton City
[13] May be indirect mortality of juveniles if they move to avoid entrainment and are preyed upon
[14] Likely only in flood years that push juvenile fish downstream

1-7	North Bay Aqueduct	▪ Entrainment	0	?	0	0	None
1-8	Exposure to toxics	▪ Chronic and acute mortality[15, 16]	X	X	X	X	▪ Source control ▪ Point-source reduction ▪ Non-point source reduction ▪ Sediment removal/capping/avoid resuspension ▪ TMDL ▪ Increased enforcement ▪ Modify pesticide/herbicide technology (shift to less toxic methods)
1-9	Predation[17]	▪ Predation by sea lions[18] and striped bass	0	X	X	X	▪ Predator management/removal ▪ Increase cover habitat ▪ Reduce ambush points ▪ Avoid future non-native introductions ▪ Modification of channel geometry (where hotspots for predation) ▪ Regulatory changes/permits for sea lion control
1-10	Propeller entrainment by cargo vessels[19]	▪ Entrainment mortality ▪ Increased vulnerability to predation ▪ Wake disturbance	0	X	X	X	▪ Increase off channel habitat ▪ Reduce vessel transit through Delta ▪ Increase channel width
1-10b	Propeller entrainment by recreational vessels	▪ Entrainment mortality ▪ Increased vulnerability to predation	0	?	X	X	▪ Public outreach/education
1-11	Legal Harvest[20] (in-basin and out-of-basin)	▪ Human take of individuals by various means	0	0	X	X	▪ Regulatory actions (e.g., zero harvest). ▪ Promote catch-release of white sturgeon ▪ Public outreach ▪ Closure of river fishery[21]

[15] Toxic effects have not been studied extensively but are assumed based on striped bass investigations
[16] We will contact Regina Linville about cause direct loss of juvenile through maternal transfer in white sturgeon (get contact from Josh Israel)
[17] Focus is on conditions that create non-natural heightened vulnerability to predation (i.e., "ambush points"; including barriers, in-channel structures, and any other physical in-channel features that attract the species, but also attract and conceal predators).
[18] Sea lions moving into Suisun--identified as likely major problem in Columbia River
[19] May not be a source of mortality based on the epibenthic nature of sturgeon
[20] Harvest is at a historical low
[21] Seasonal/zone closure could reduce abortion of eggs from hooked/escaped fish

1-11b	Illegal harvest	▪ Human take of individuals by various means	0	0	X	X	▪ Increased law enforcement ▪ Seasonal fishing closures (all fishing) in spawning areas ▪ Increased fines and penalties ▪ Increased prosecution ▪ Public outreach ▪ Restructure regulationss to restrict possession of sturgeon fishing gear
1-12	Insufficient food supplies/location[22]	▪ Reduced growth/ health/starvation	0	X	0	0	▪ See Conservation theme 6
1-13	Disease	▪ Infection of wild fish	X	X	X	X	▪ Hatchery discharge disinfection ▪ Reduce elevated water temperature ▪ Limit disease transport from other areas ▪ Regulate commercial hatcheries to prevent introduction of disease
1-14	DCC operations	▪ Delay in upstream migration ▪ Delay in outmigration and increased predation resulting from entrainment into the central/south Delta	0	?	?	?	▪ Re-operate DCC to improve migration success and survival[23]

[22] food limitations have not been investigated – assumed based on general reduction in organic production
[23] No data, may not be able to pass DCC if on bottom

1-15	Water temperature	▪ Direct mortality ▪ Shift in timing of spawning, emergence, etc.	X	X	0	0	▪ Modify upstream reservoirs to provide for cold water releases (multi-level temperature control device) ▪ Modify release operations ▪ Coldwater pool management in reservoirs ▪ Reestablish SRA in key locations ▪ Augment with cold groundwater flows ▪ Increase access to cold water reaches ▪ Expansion of Shasta to provide for coldwater releases ▪ Seasonal blending of releases for temperature management ▪ Reoperate RBDD to allow upstream passage to cooler water
1-16	Monitoring mortality	▪ Direct take	0	X	X	X	▪ Stop monitoring ▪ Change monitoring techniques ▪ Target monitoring to avoid redundancy ▪ Use BMPs for handling and release of fish (e.g., better gears to reduce mortality) ▪ Improve permit compliance
1-17	Red Bluff Diversion Dam	▪ Entrainment loss ▪ Loss to turbulence	X	X	0	X	▪ Seasonal operations to avoid entrainment ▪ Redesign screen to effectively screen stugeon[24]
1-18	In-channel construction/levee maintenance activities and dredging	▪ Direct take	X	X	X	X	▪ Sound attenuation devices ▪ Seasonal windows ▪ Increase compliance with minimization measures ▪ Use less adverse methods to pile drive/install structures
2. Increase species production (reproduction, growth, survival)							

[24] Efficacy for sturgeon questionable

2-1	Insufficient food supplies/food quality (e.g., non-natives with less energy)/location	▪ Reduced growth, health, starvation ▪ Use of non-native, low nutrient food sources	0	X	X	X	See Conservation theme 6
2-2	Reduced suitable spawning habitat	▪ Insufficient spawning conditions	X	0	0	X	▪ Enhance spawning substrate availability and/or quality ▪ Increase access to spawning habitats ▪ Improve flow conditions to increase the frequency, duration, and area of spawning habitat ▪ Reduce fine sediment erosion/deposition ▪ Encourage channel meander and floodplain inundation (?)
2-3	Reduced suitable rearing habitat	▪ Increased vulnerability to predation ▪ Increased competition ▪ Reduced DO and other water quality parameters ▪ Reduction in carrying capacity ▪ Reduced duration of rearing in highly productive flooded habitat producing food ▪ In-filling of rearing pools ▪ Spawning in low-turbidity tailwater areas	0	X	X	0	▪ Reduce channel velocity ▪ Increase floodplain habitat ▪ Levee set-backs ▪ Riparian corridor enhancement ▪ Increase inputs of large woody debris and overhead cover ▪ Reduce predator “hot spots” ▪ Increased access to spawning habitat also increases access to rearing habitat ▪ Increase access to existing habitat ▪ Reduce deposition by fines to increase macroinvertebrate production ▪ Increase intertidal flats ▪ Mimic natural hydrograph with reservoir releases to improve turbidy

2-4 (seasonal)	Reduced suitable adult habitat (upstream riverine—holding habitat)	▪ Insufficient spawning habitat ▪ False migration pathways resulting from delta configuration ▪ Insufficient holding habitat (?)	0	0	0	X	See measures for Stressor 2-2 and 1-15. ▪ Enhance spawning substrate availability and/or quality ▪ Increase access to spawning habitats ▪ Reduce fine sediment erosion/deposition ▪ Encourage channel meander ▪ Improve connectivity of floodplain to channel ▪ Modify upstream reservoirs to provide for cold water releases (multi-level temperature control device) ▪ Modify release operations ▪ Coldwater pool management in reservoirs ▪ Reestablish SRA in key locations (e.g., holding pools) ▪ Increase quality and availability of adult habitat
2-5	Sublethal exposure to toxics[25]	▪ Increased vulnerability to disease ▪ Reduced growth rates ▪ Increased vulnerability to predation ▪ Reduced reproductive success[26]	X	X	X	X	▪ Source control of heavy metals ▪ Point-source reduction ▪ Non-point source reduction ▪ Sediment removal/capping/avoid resuspension ▪ TMDL ▪ Increased enforcement ▪ Modify pesticide/herbicide technology (shift to less toxic methods)
2-6	Competition	▪ Reduced food supplies. ▪ Increased energy expenditure ▪ Potential displacement from suitable habitat	0	?[27]	?	?	▪ Non-native species management/control ▪ Reduce/avoid future introductions ▪ Improve habitat for native riverine species ▪ Reduce habitat for non-native species ▪ Increase quality and availability of spawning and rearing habitat

[25] Sturgeon are benthic, so they are exposed to toxics in sediments in addition to water column
[26] Selenium is problem for egg maturation/Hg
[27] Juvenile may compete with non-native clams

2-7	Water quality problems (e.g., elevated temps)	▪ Impediment/barrier to migration ▪ Increased physiological stress ▪ Reduced health/growth	X	X	0	0	▪ Increase flushing flows ▪ Storm water pre-treatment ▪ Reduce exposure to seasonally elevated temps (see measures for 2-4)
2-8	Existing or New Levees	▪ Extent of floodplain habitats reduced (exclusion of fish from habitat)	0	?	X	X	▪ Levee set backs ▪ Improved access/habitat within flood bypasses ▪ Flood shallow islands and channel margins
2-9	Altered hydrology	Insufficient flow (reduced area and volume of habitat, passage, etc) Seasonal timing of flow inconsistent with life stage requirements	X	X	?	X	▪ Restore seasonal natural hydrology ▪ Manage instream flow releases to optimize physical habitat for each life stage (e.g., seasonal frequency and duration of floodplain inundation)
2-10	Passage (see below)						
3. Increase habitat quality and availability[28]							
4. Increase habitat diversity[28]							
5. Increase species resilience[28]							
6. Increase food availability (phytoplankton, zooplankton, macroinvertebrates, forage fish, etc)[28]							

[28] Note to reviewers – stressors, impact mechanisms, and conservation measure concepts for Themes 3-6 will be addressed at the next technical meeting